



Kinetic Metallization™

Repair of IVD Al Coatings and Mg Alloys
Aircraft Components Using
Portable Kinetic Metallization Systems

NAVAIR SBIR Ph I & II Contract #N68335-05-C-0296

NAVAIR SBIR Ph I Contact #N68335-07-C-0448



SERDP/ESTCP Session-6 "Cd Replacements"

Inovati

Ralph Tapphorn, VP of Technology

Feb. 27, 2008

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 27 FEB 2008		2. REPORT TYPE		3. DATES COVERED 00-00-2008 to 00-00-2008	
4. TITLE AND SUBTITLE Kinetic Metallization. Repair of IVD Al Coatings and Mg Alloys Aircraft Components Using Portable Kinetic Metallization Systems				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Inovati,1501 Cook Place ,Santa Barbara,CA,93117				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Surface Finishing and Repair Issues for Sustaining New Military Aircraft Workshop, February 26-28, 2008, Tempe, AZ. Sponsored by SERDP/ESTCP.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 24	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Problem - Field & Depot Repair of Damaged IVD-AI & Mg Alloys

❑ Aircraft Components

- ❑ Landing Gear & HS Steel
- ❑ Mg Alloy Gearboxes
- ❑ IVD-AI field repair

❑ Customer Requirements

- ❑ On aircraft carriers & depots
- ❑ Environmentally sustainable
- ❑ Meets Navy JTP-2003
- ❑ **Portable system & Handheld spray gun**
- ❑ Robotic deployment for OEM Applications



Organizations & Platforms with Needs for Coating Repairs

■ NADEP Facilities

- PEO(T) F/A-18, EA-18G
- PMA-271 E-6B
- PMA-276 H-1
- PMA-275 V-22
- JSF JPO F-35 Lightning II

■ Air Force Depot Facilities

- F-22
- C-17

■ Commercial Aircraft

- A380 & B787



Introduction to Kinetic Metallization™ (KM)

- Metal deposition through particle impact
- low-temperature \ll melting point
- high particle velocity > 500 m/s
- gas velocity below Mach 1
 - He, 300K, 980 m/s
 - GN2, 300K, 330 m/s

Substrate

Introduction to Kinetic Metallization™ (KM)

- Metal deposition through particle impact
- low-temperature \ll melting point
- high particle velocity > 500 m/s
- gas velocity below Mach 1
 - He, 300K, 980 m/s
 - GN2, 300K, 330 m/s

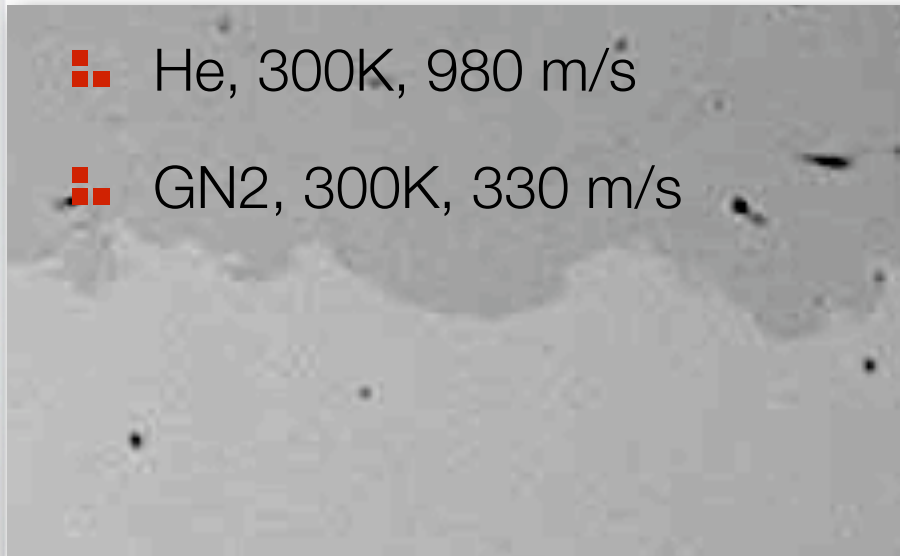


Introduction to Kinetic Metallization™ (KM)

- Metal deposition through particle impact
- low-temperature \ll melting point
- high particle velocity > 500 m/s
- gas velocity below Mach 1

- He, 300K, 980 m/s

- GN2, 300K, 330 m/s




Deposit
Substrate

Powder

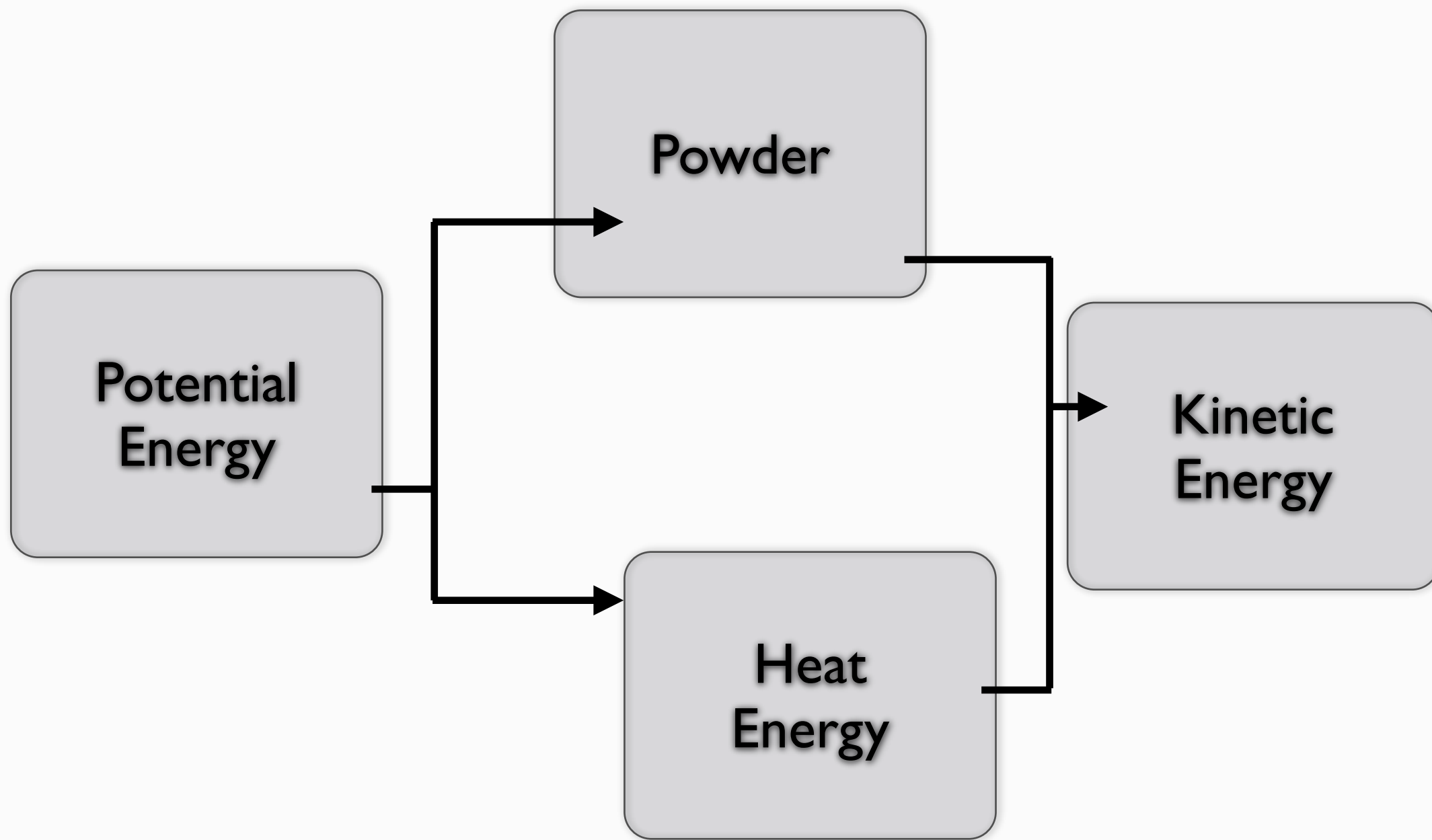
**Potential
Energy**

**Kinetic
Energy**

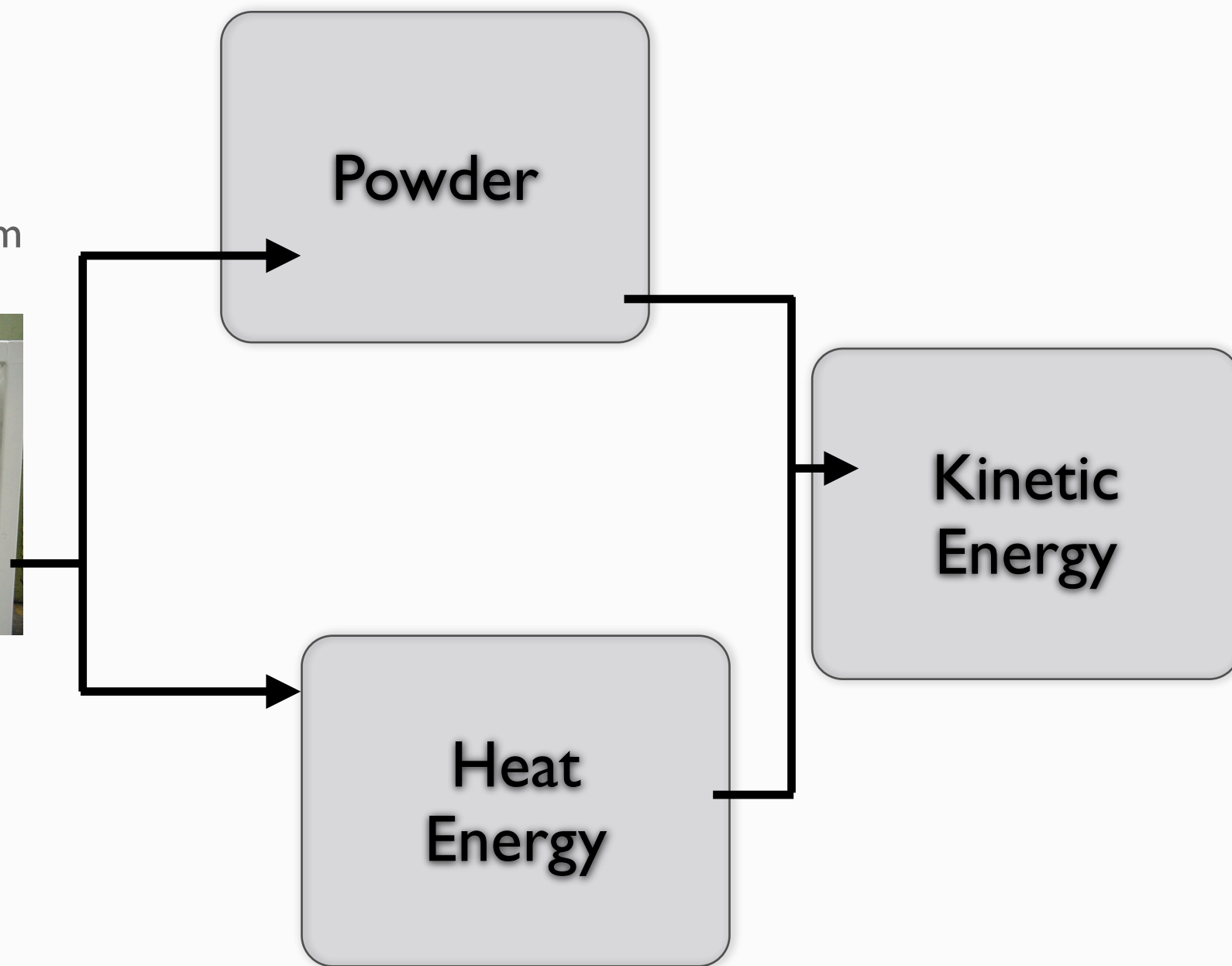
**Heat
Energy**



INOVATI



Helium Storage System



Helium Storage System



Powder
Fluidizing
Unit



Heat
Energy

Kinetic
Energy



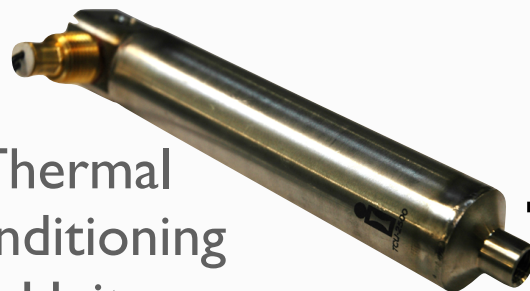
Helium Storage System



Powder
Fluidizing
Unit



Thermal
Conditioning
Unit



Kinetic
Energy



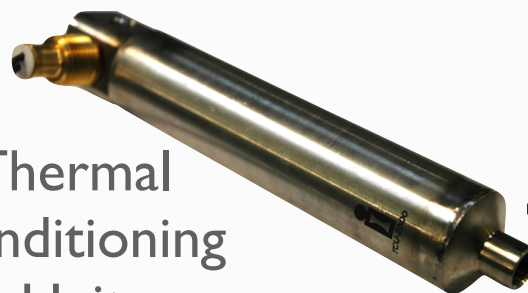
Helium Storage System



Powder
Fluidizing
Unit



Thermal
Conditioning
Unit



Deposition
Nozzle



❖ Kinetic Metallization Systems

- ❖ Low temperature & Pressure (1 MPa)
- ❖ KM-CDS, KM-PRO, & Portable KM
- ❖ Customers Worldwide (US, Japan, Australia, China)
- ❖ 4 units delivered to Japan last year

❖ KM Coatings

- ❖ Al-Trans® corrosion resistant
- ❖ WC-Co & $\text{Cr}_3\text{C}_2\text{-NiCr}$ wear/corrosion resistant
- ❖ MCrAlY wear/oxidation resistant



KM Handheld Gun





KM Compared to CS & HVOF

	KM	CS	HVOF
Max. Temp.	400°C	800°C	1650°C
Heat Source	2.5kW Integral	47kW Remote	Combustion
Accelerant Gas	He, N ₂ , He/N ₂	He, N ₂ , He/N ₂	Explosive Comb.
Bonding Mechanism	Metallurgical	Metallurgical	Mechanical
Powder Size	0.5 to 45µm	< 100 µm	+15µm, -44µm
Powder Dispenser	Brush-Sieve	TS Feeder	TS Feeder
State of Deposition	Solid	Solid	Liq./Semi-solid
Gun Pressure	<1MPa	>4MPa	<1 MPa
Gun/Nozzle Mass	1 kg	20 kg est.	> 4 kg

Al-Trans[®] Kinetic Metallization

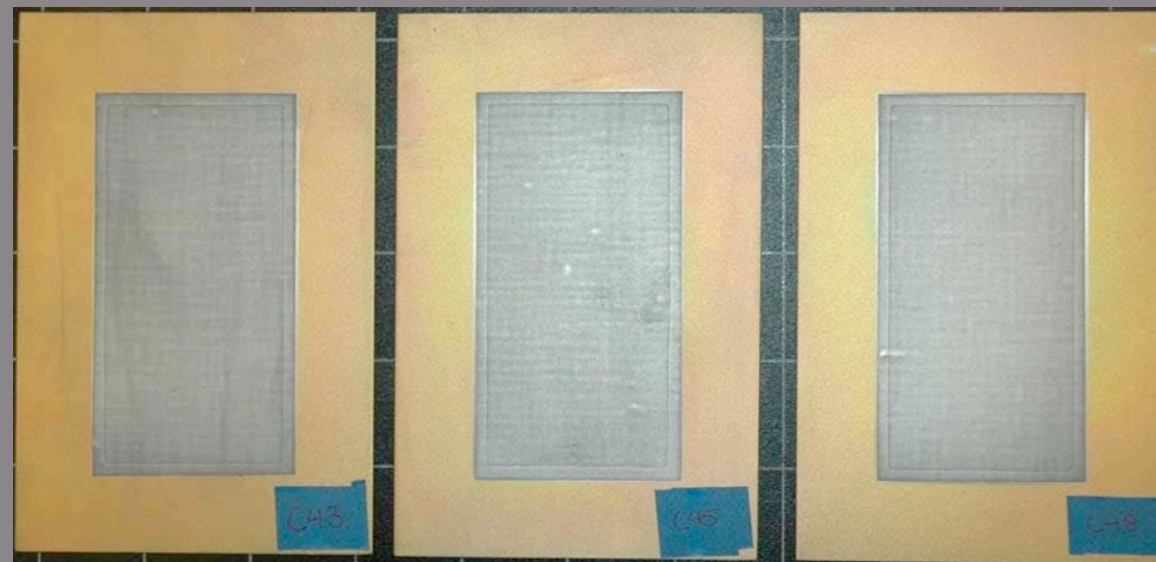
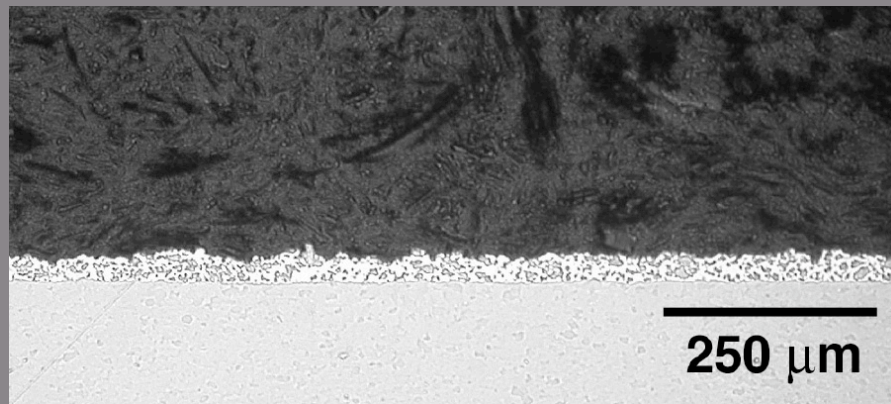
- Portable KM System
 - Handheld KM spray gun
 - Cartridge powder canisters
- Al-Trans[®] Coating
 - Aluminum-Transition Metal (Cr)
 - Superior corrosion resistant
 - Replaces IVD-Al and Cd
 - Replaces liquid-based plating



Qualification of Portable System for Repair of Damage IVD-Al Coatings



Laboratory Model of Handheld KM Gun



KM Al-Trans® Repair Coupons - 1.5 ± 0.3 mils





Al-Trans[®] Kinetic Metallization Qualified per JTP-2003

General & Galvanic Test	Reparability Test	Reparability Test
Strip-ability	Appearance	Unscribed Salt Fog
Open Circuit Potential	Bend Adhesion	Scribed Salt Fog
EIS/Tafel Analysis	Paint Adhesion	Unscribed SO ₂ Salt Fog
Visual Exam	Scribed Painted Coating	Scribed SO ₂ Salt Fog



500 Hours

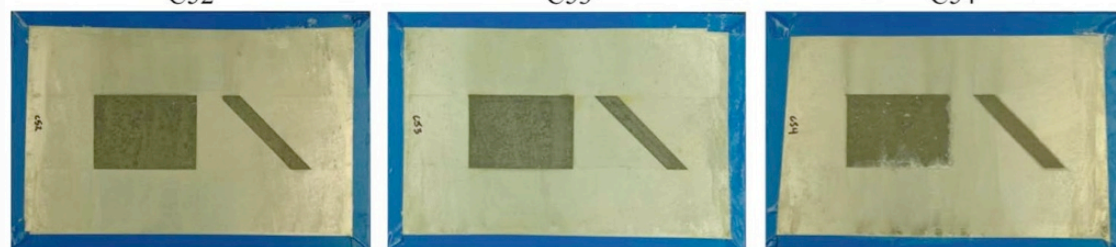


1500 Hours

C52

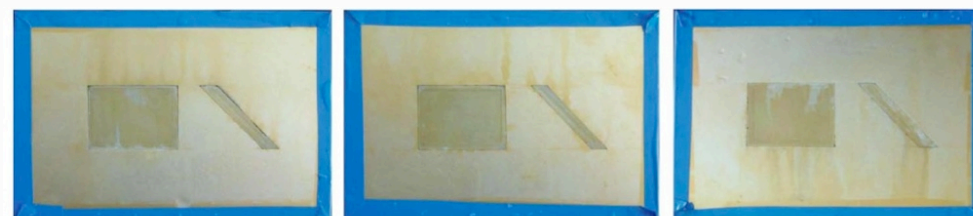
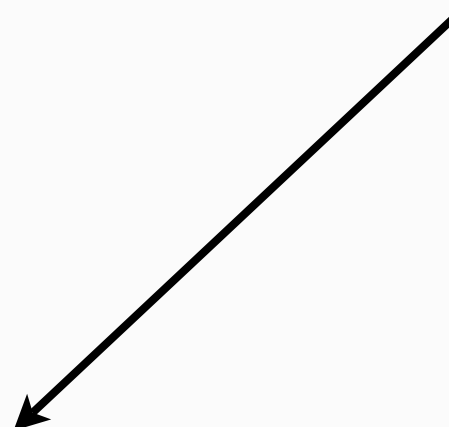
C53

C54

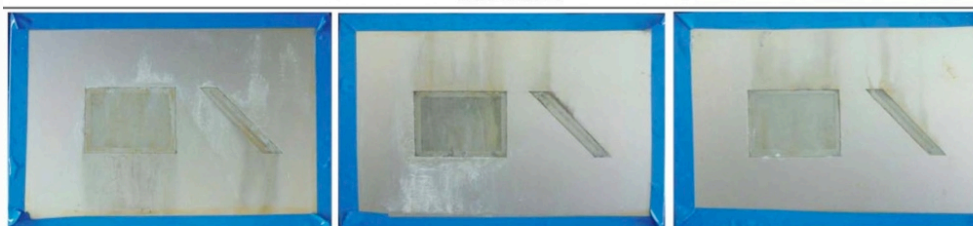


3500 Hours

3500 Hrs Neutral Salt Fog
KM Al-Trans®



500 Hours

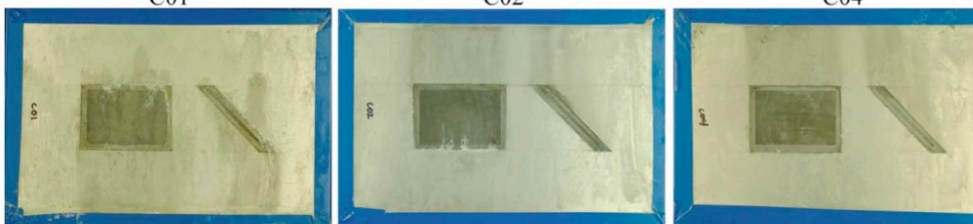


1500 Hours

C01

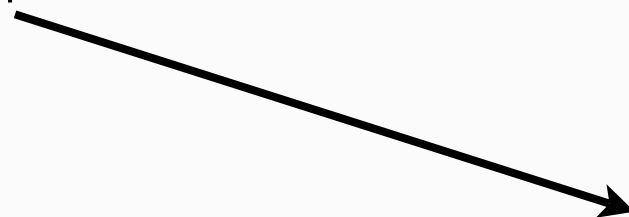
C02

C04

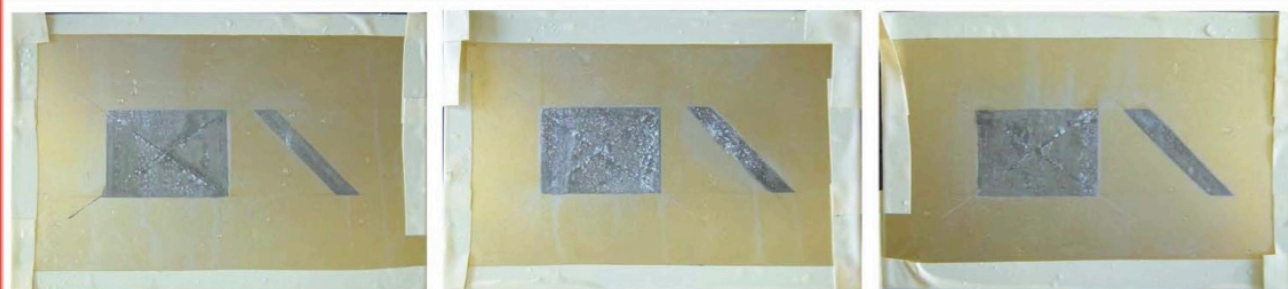


3500 Hours

3500 Hrs Neutral Salt Fog
Brush Cd - Cr6+
Control Specimens



INOVATI

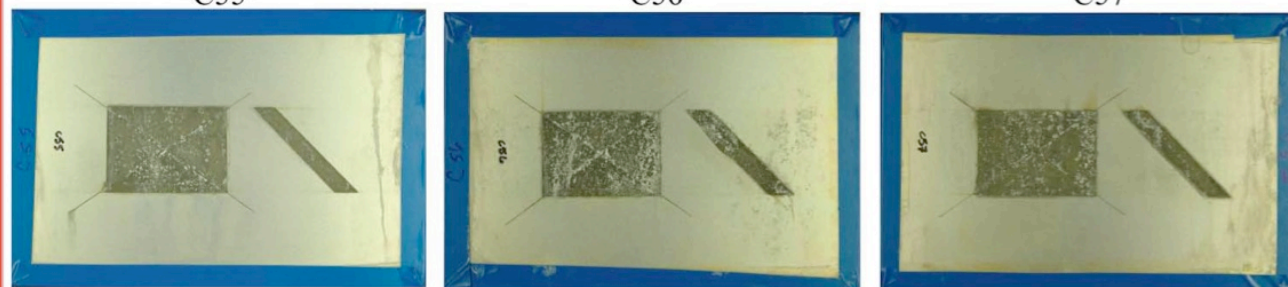


250 Hours

C55

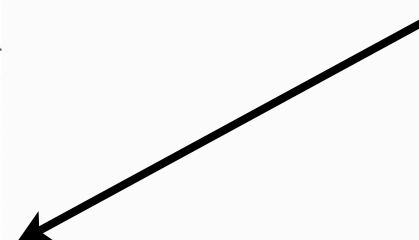
C56

C57

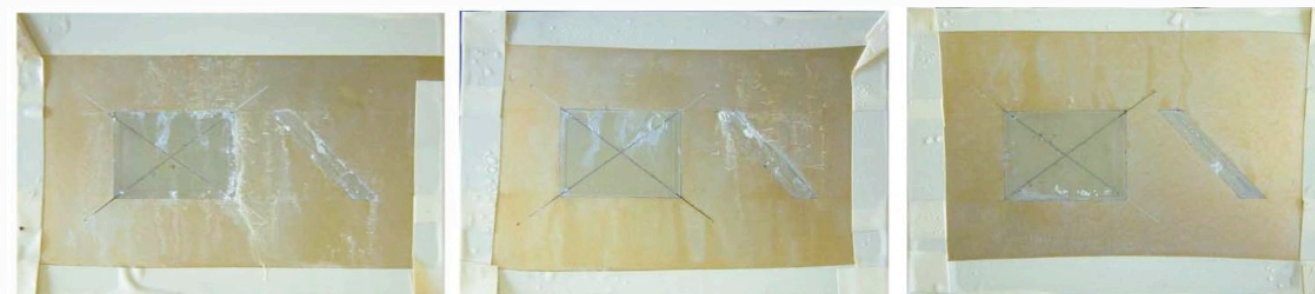
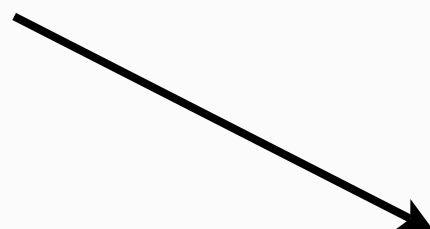


1300 Hours

1300 Hrs Neutral Salt Fog
Scribed KM Al-Trans[®]



1300 Hrs Neutral Salt Fog
Scribed Brush Cd - Cr6+
Control Specimens



250 Hours

C05

C06

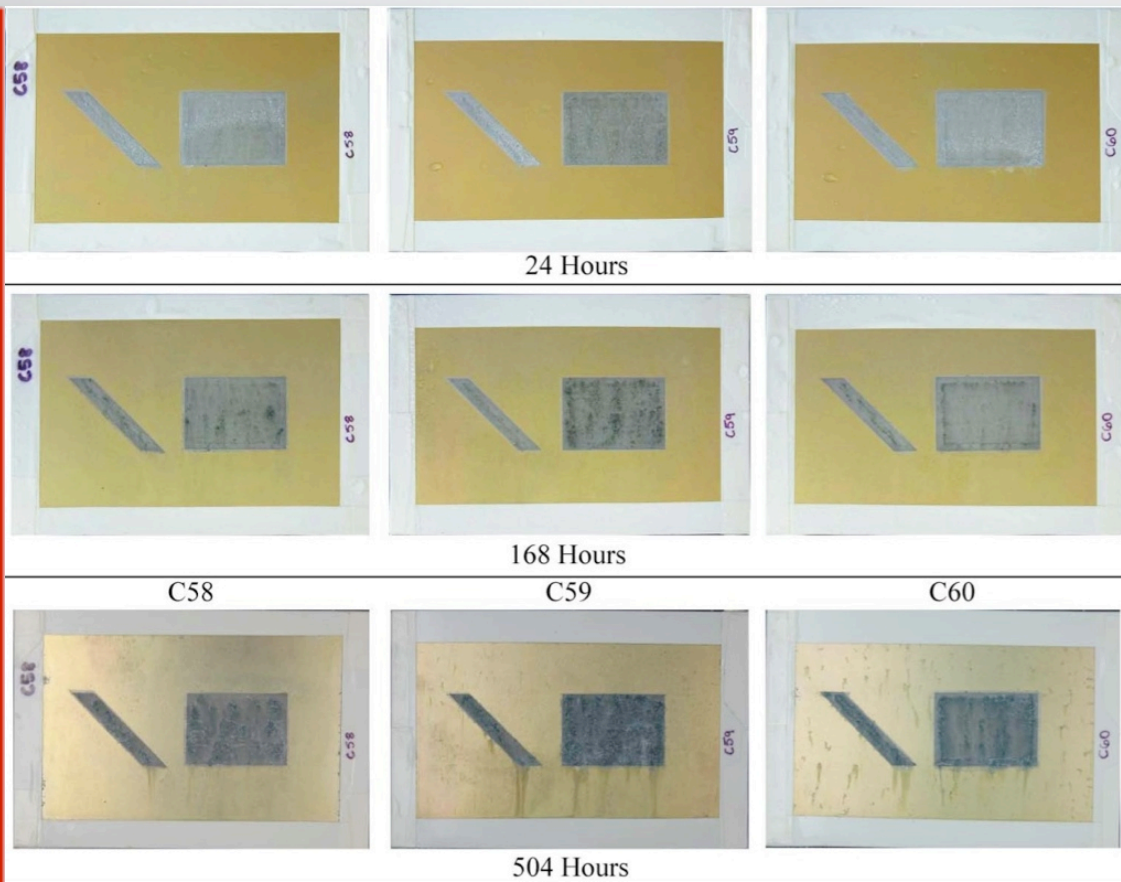
C07



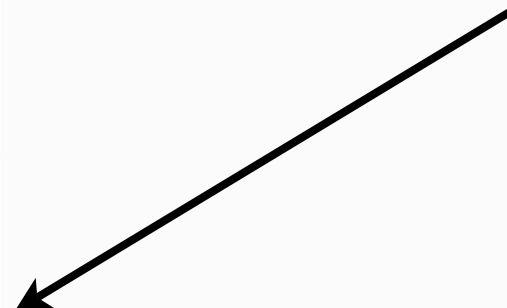
1300 Hours



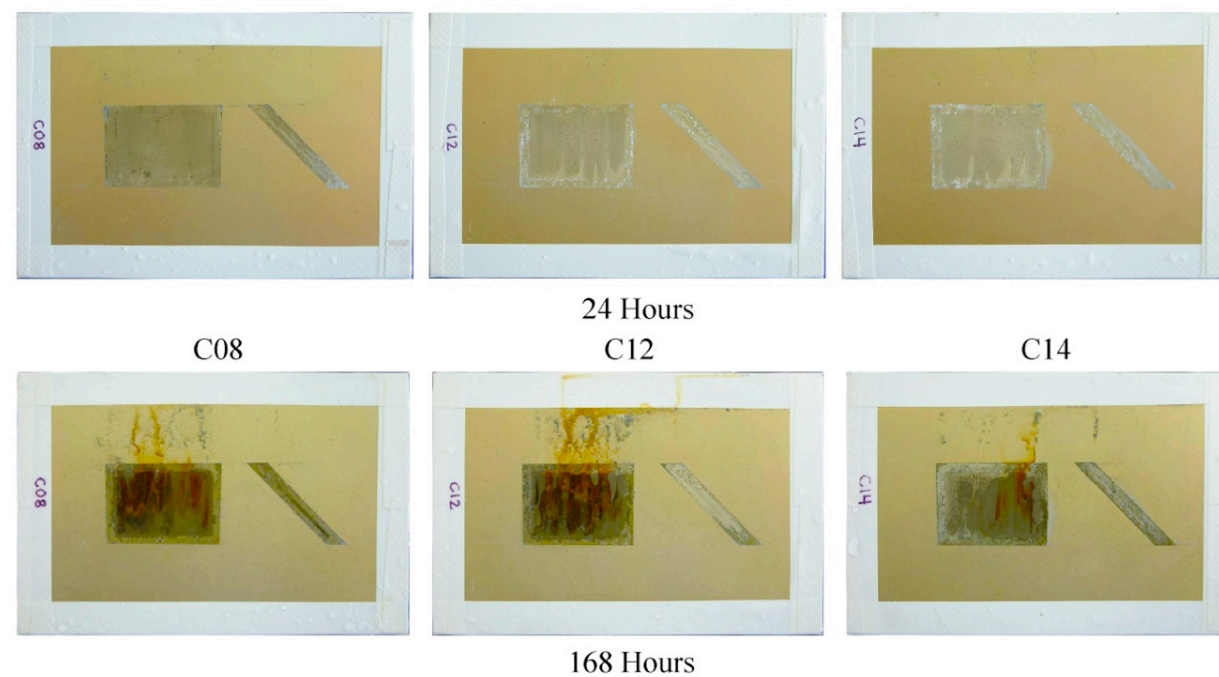
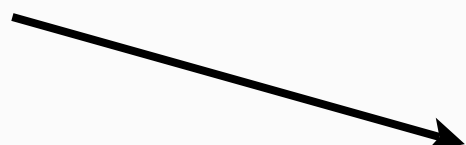
INOVATI

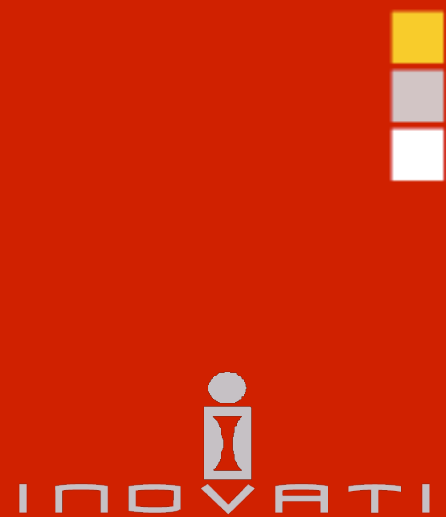


500 Hr Cyclic SO_2 Salt Fog
KM Al-Trans[®]



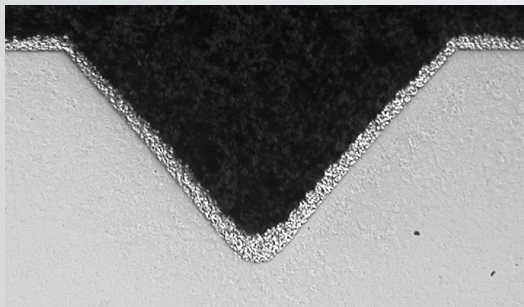
168 Hrs Cyclic SO_2 Salt Fog
Brush Cd - Cr6+
Control Specimens





JTP-2003

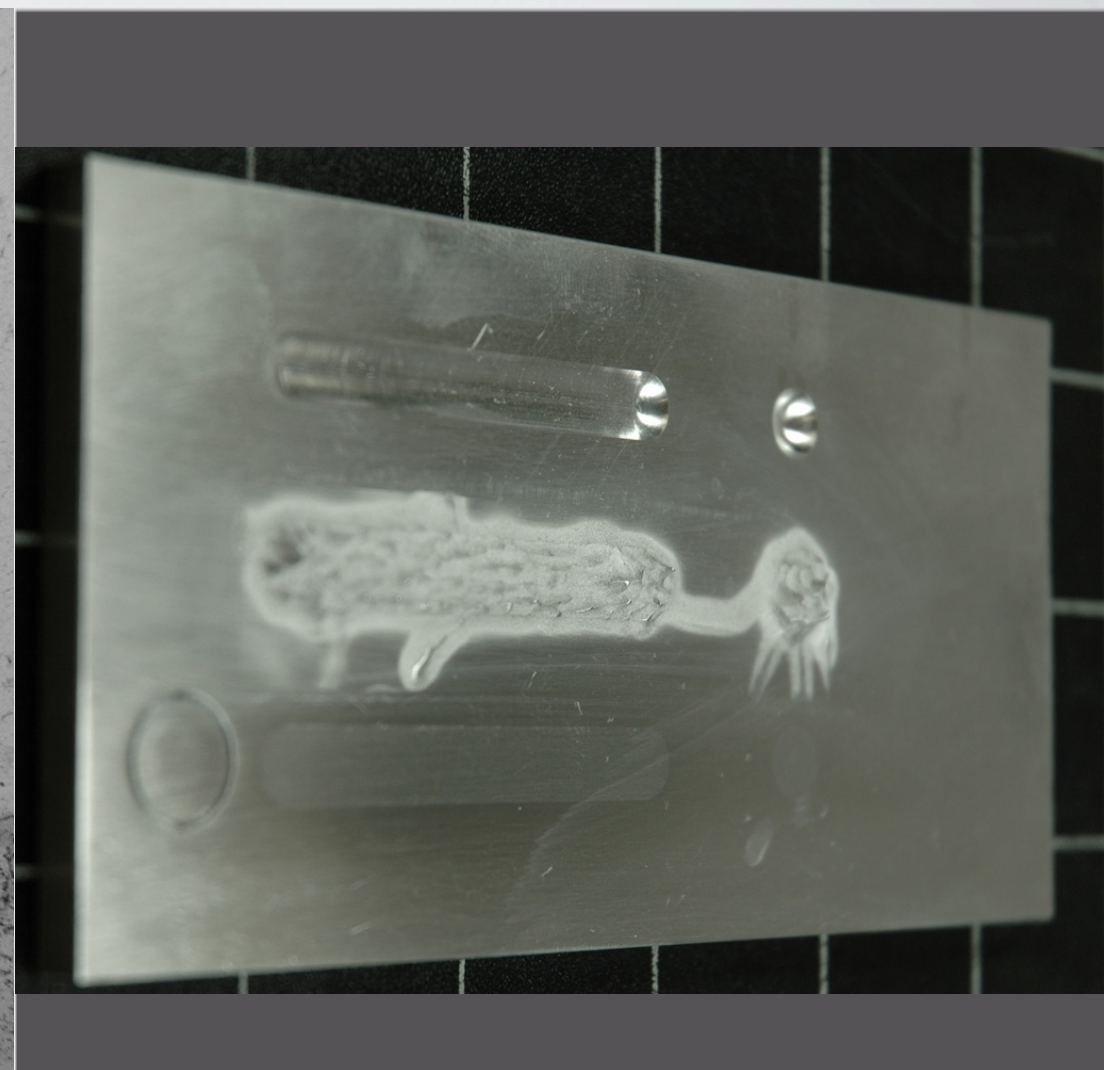
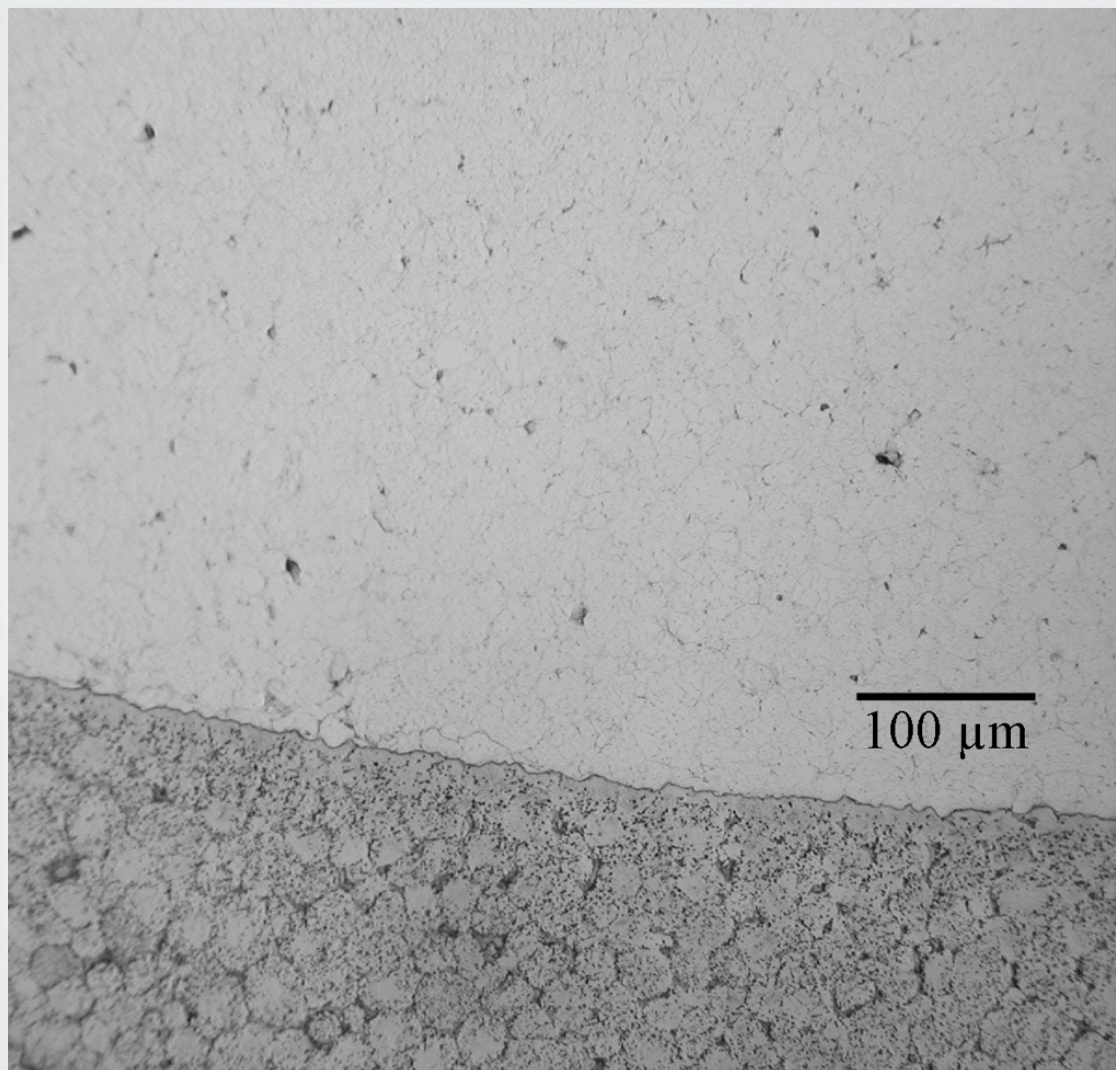
Al-Trans[®] Kinetic Metallization



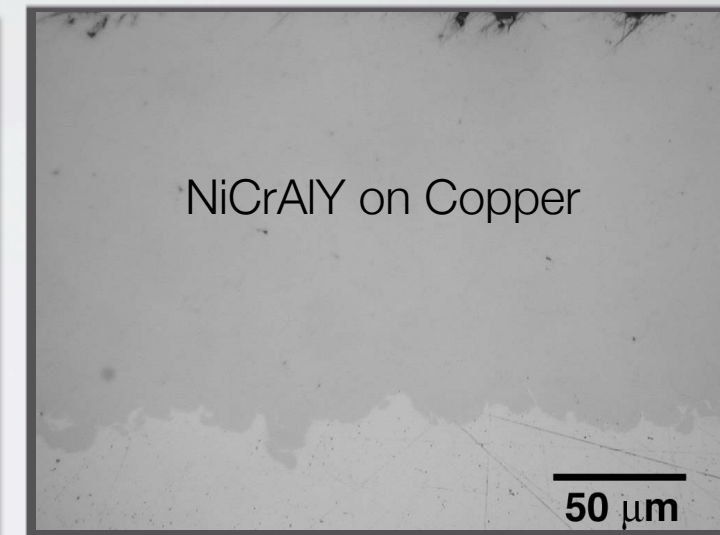
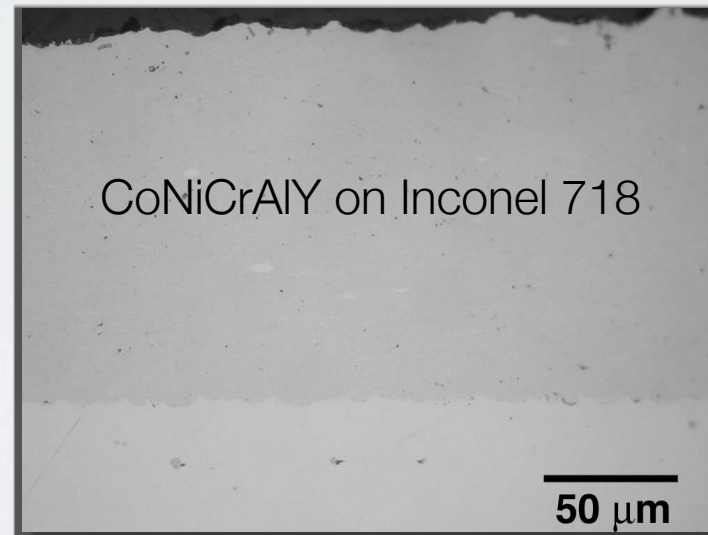
Reparability Test	JTP	Acceptance Criteria	Pass/Fail
Hydrogen Embrittlement	3.6.1 3.7.1	200 Hr/75% ASTM F519	Pass
Hydrogen Re-Embrittlement	3.6.1 3.7.1	200 Hr/75% ASTM F519	Pass
Corrosion Resistance 14 Fluids	3.3.4	No Coat Degradation Compared to Brush Cd	Pass
Stress Corrosion Cracking	4.3	SEM Fractography	Pass



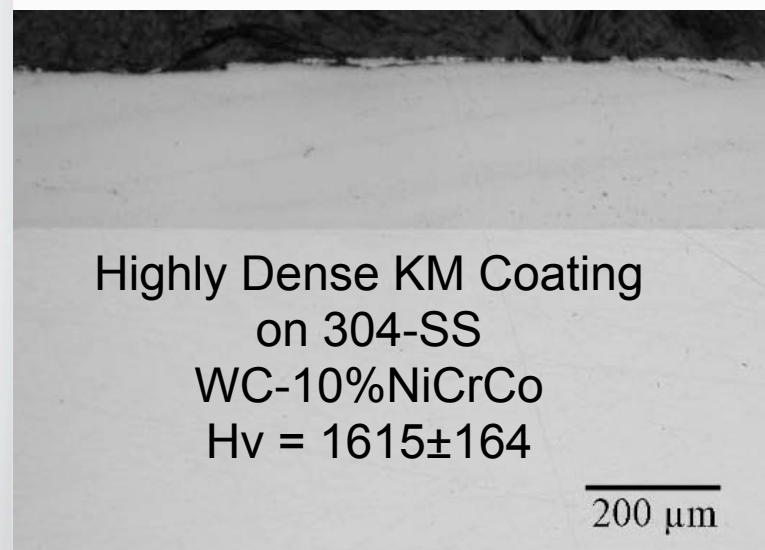
Al-Trans[®] Kinetic Metallization Repair Demo IVD-Al on F-18 Axle



NAVAIR Ph I SBIR - 2007
KM Fillet Repair CP-Al on ZE41A Mg Alloys



Other Coating Applications Using Kinetic Metallization Systems



Inovati

Ralph Tapphorn, VP of Tech.

Phone (805) 571-8384 X12

Mobile (805) 637-7040

rtapphorn@inovati.com